

## **EH Resident Competency 1.26**

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**Competency 1.26** EH Residents shall demonstrate a working level knowledge of electrical safety.

### **1. Supporting Knowledge and Skills**

- a. Discuss the different requirements for operation and worker qualifications for high versus low voltage. Include procedural differences such as resetting trips.
- b. Describe the following elements of safe work practices for electrical workers:
  - Work planning
  - Work package, including procedures
  - Personal protective equipment
  - Training/qualification
- c. Given a piece of electrical equipment, discuss the potential sources of shock hazards, the degree of the hazard associated with different equipment, and preventive measures required.
- d. Discuss the potential severity of an electrical shock based on the current flow, current path, and the circuit interrupt speed of any overcurrent or ground fault devices in the circuit.
- e. Describe the difference between equipment grounding, system grounding, and grounding.
- f. Describe the purpose and operation of a ground fault circuit interrupter (GFCI).

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### 2. Self-Study Activities (corresponding to the intent of the above competency)

Below are two web sites containing many of the references you may need.

Web Sites		
Organization	Site Location	Notes
Department of Energy	<a href="http://wastenot.inel.gov/cted/stdguido.html">http://wastenot.inel.gov/cted/stdguido.html</a>	DOE Standards, Guides, and Orders
OSHA	<a href="http://www.osha-slc.gov/">http://www.osha-slc.gov/</a>	OSHA documents and search engine
U.S. House of Representatives	<a href="http://law.house.gov/cfr.htm">http://law.house.gov/cfr.htm</a>	Searchable Code of Federal Regulations

**Read** 29 CFR 1910.332, “Training” of Subpart S, *Electrical*.

EXERCISE 1.26-A Referring to 29 CFR 1910.332, summarize the training requirements.

**Read** DOE/ID-10600, *Electrical Safety Guidelines*, Section 2.9, “Working Space Around Electrical Equipment.”

EXERCISE 1.26-B Discuss the different requirements for equipment operation for high versus low voltage.

**Read** DOE/ID-10600, *Electrical Safety Guidelines*, Section 2.11, “Work Procedures,” and Section 2.12, “Electrical Protective Clothing and Equipment.”

EXERCISE 1.26-C Describe the following elements of safe work practices for electrical workers:

- Work planning
- Work package, including procedures
- Personal protective equipment
- Training/qualification

**Read** Department of Energy: *Electrical Safety Guidelines*, Section 2.9, “Working Space Around Electrical Equipment.”

EXERCISE 1.26-D Why are minimum distance requirements established for both low and high voltage systems?

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EXERCISE 1.26-E In your workspace, a control panel for an electrical distribution system for the facility is to be installed. Voltages in the system are between 600 volts and 25,000 volts. The wall closest to where the panel is to be installed is a grounded wall constructed of concrete. Using NEC Table 110-34/OSHA Table S-2 located in Section 2.9.2, determine the "condition" that applies.

EXERCISE 1.26-F Using NEC Table 110-34/OSHA Table S-2, and the minimum distances for condition 2, determine the minimum distance the control panel must be from the wall.

**Read** Department of Energy: *Electrical Safety Guidelines*, Appendix A: "Understanding Electrical Safety," A-4, A-5.

EXERCISE 1.26-G Discuss the potential severity of an electrical shock based on the current flow, current path, and the circuit interrupt speed of any overcurrent or ground fault devices in the circuit.

**Read** Department of Energy: *Electrical Safety Guidelines*, Section 4: "Grounding."

EXERCISE 1.26-H Describe the difference between equipment grounding, system grounding, and grounding.

**Read** Department of Energy: *Electrical Safety Guidelines*, Section 8: "Temporary Wiring," Item 8.2, Ground Fault Circuit Interrupters.

EXERCISE 1.26-I Describe the purpose and operation of a ground fault circuit interrupter (GFCI).

### 3. Summary

Identification and acknowledgment of electrical hazards in the workplace is the first step in developing an electrical safety program. Once identified, precautions must be put into place to prevent electric shock to the worker. Precautions include design factors for equipment or spaces, or personal protective equipment that ranges from rubber gloves and mats (blankets) to the tools used. All must be considered when analyzing an electrical safety program. For more information, refer to the *Electrical Surveillance Guide*, prepared by the Oak Ridge Operations Office for the U.S. Department of Energy.

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### 4. Exercise Solutions

EXERCISE 1.26-A Referring to 29 CFR 1910.332, summarize the training requirements.

ANSWER 1.26-A Below is a summary of training requirements found in 29 CFR 1910.332, "Training" of Subpart S, *Electrical*:

- The training requirements apply to employees who face a risk of electric shock that is not reduced to a safe level by the electrical installation requirements of 1910.303 through 1910.308.
- Employees who face such a risk are required to be trained. The CFR targets occupations requiring training in Table S-4. Other employees who also may reasonably be expected to face a comparable risk of injury due to electric shock or other electrical hazards must also be trained.
- Qualified persons (i.e. those permitted to work on or near exposed energized parts) shall, at a minimum, be trained in and familiar with the following:
  - The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment
  - The skills and techniques necessary to determine the nominal voltage of exposed live parts
  - The clearance distances specified in 1910.333(c) and the corresponding voltages to which the qualified person will be exposed.
- The degree of training provided depends on the risk to the employee.

EXERCISE 1.26-B Discuss the different requirements for equipment operation for high versus low voltage.

ANSWER 1.26-B For low voltage (<600 volts), a working space with a minimum width of 30 inches and a depth of 3, 3 ½, or 4 feet, depending on conditions, is required.

For high voltage (>600 volts), minimum clearances of 3-10 feet are required, depending on the conditions.

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EXERCISE 1.26-C Describe the following elements of safe work practices for electrical workers:

- Work planning
- Work package, including procedures
- Personal protective equipment
- Training/qualification

ANSWER 1.26-C Before work is begun, the qualified worker shall ensure that the job to be done is in compliance with written procedures pertaining to electrical work. Electrical work shall be performed according to written safety procedures and approved electrical safety guidelines or manuals. Electrical work shall be directed by a supervisor, qualified by training in safety-related work practices that pertain to his/her respective job assignments and those of his/her employees.

Qualified workers are responsible for avoiding and preventing accidents while performing electrical work. Personnel shall wear or use protective clothing or equipment that is approved for safe performance of work.

EXERCISE 1.26-D Why are minimum distance requirements established for both low and high voltage systems?

ANSWER 1.26-D To allow for sufficient space between the voltage source and the nearest conductor or ground in the event that the worker should make contact with live components. It ensures that the worker cannot touch both the source and the ground simultaneously.

EXERCISE 1.26-E In your workspace, a control panel for an electrical distribution system for the facility is to be installed. Voltages in the system are between 600 volts and 25,000 volts. The wall closest to where the panel is to be installed is a grounded wall constructed of concrete. Using NEC Table 110-34/OSHA Table S-2 located in Section 2.9.2, determine the "condition" that applies.

ANSWER 1.26-E Condition 2 states "where there are exposed live components on one side and grounded parts on the other such as concrete, brick, and tile walls that are considered to be grounded parts."

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EXERCISE 1.26-F Using NEC Table 110-34/OSHA Table S-2, and the minimum distances for condition 2, determine the minimum distance the control panel must be from the wall.

ANSWER 1.26-F The minimum distance for equipment in the voltage and the “condition” is 6 feet.

EXERCISE 1.26-G Discuss the potential severity of an electrical shock based on the current flow, current path, and the circuit interrupt speed of any overcurrent or ground fault devices in the circuit.

ANSWER 1.26-G From Figure A-4, one can determine that a 100 mA current flowing for three seconds through a human adult body will cause death by electrocution. It is imperative that all electrical equipment be connected to a properly wired circuit with an equipment grounding conductor (EGC).

EXERCISE 1.26-H Describe the difference between equipment grounding, system grounding, and grounding.

ANSWER 1.26-H Grounding is used to give proper protection of such systems in order to safely clear the phase-to-ground faults that can occur.

Circuit and system grounding consist of connecting the grounded conductor, the equipment grounding conductor, the grounding bus bar, and all metal enclosures to ground. This is accomplished by connecting a properly sized, unspliced grounding electrode conductor between the grounding busbar and the grounding electrode system. There are three fundamental purposes for grounding an electrical system:

1. To limit excessive voltage from lightning, line surges, and crossovers with higher voltage lines.
2. To keep conductor enclosures and noncurrent-carrying metal enclosures and equipment at zero potential to ground.
3. To facilitate the opening of overcurrent protection devices in case of insulation failures.

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Equipment grounding systems, which consist of interconnected networks of equipment grounding conductors, are utilized to perform the following functions:

1. Limit the voltage to ground (shock voltage) on the exposed noncurrent-carrying metal parts of equipment raceways and other conductor enclosures in case of ground faults.
2. Safely conduct ground fault current at sufficient magnitude for fast operation of the circuit overcurrent protection devices.

EXERCISE 1.26-I Describe the purpose and operation of a ground fault circuit interrupter (GFCI).

ANSWER 1.26-I GFCIs are devices that sense when current - even a small amount - passes to ground through any other path than the proper conductor. When this condition exists, the GFCI quickly opens the circuit, stopping all current flow to the circuit and to the person receiving the ground fault shock